

Junta SUGIYAMA\* & Shoji Goto\*\*: **Coprophilous  
Fungi from Karakorum I.**

杉山純多\*・後藤昭二\*\*: カラコルム産糞生菌類 I

(Plate I)

Goat dungs were forwarded to us from Mr. K. Ito for mycological studies, all collected in Karakorum, Pakistan in 1965, by him who was sent to there as a member of the University of Tokyo Karakorum Expedition. Several moulds and yeasts were isolated from these materials placed at our disposal. The present paper represents part of the studies now in progress.

Some important contributions on dung mycoflora in Asia have thus far been made by Mahju (1933), Ginai (1936), Tubaki (1954) and Soneda (1959). Mahju (1933) reported twenty-nine different fungus species belonging to twenty-one genera (i. e., 4 species in Phycomycetes, 12 in Ascomycetes, 5 in Basidiomycetes, and 8 in Fungi Imperfecti, respectively) from rabbit, goat, sheep dungs, etc. collected in the Zoological Garden, Lahore, India. Likewise, Ginai (1936) described thirty-five coprophilous fungi from India. Many coprophilous fungi belonging to Hyphomycetes, i. e., sixteen species including the two new taxa, were described to occur by Tubaki (1954) in dungs of various animals in Japan. Also, Soneda (1959) reported nine genera and twenty species of coprophilous yeasts isolated from various animal dungs in middle Japan, five of which he reported were new species.

So far as we are aware, there is no or very little information available at present concerning the coprophilous fungi in Karakorum. Some information, therefore, will be of worth reporting here as a contribution to mycoflora of the Karakorum region.

In the present study, seven species, including one new species that belongs to the genus *Sporobolomyces* (Sporobolomycetaceae) and one new variety of *Cryptococcus albidus* (Cryptococcaceae), were recognized from materials examined.

The present authors wish to thank Prof. H. Shiraki and Mr. K. Ito for their kindness of giving a chance to study these interesting samples mycologically. The senior author (J. S.) extends his cordial gratitude to Prof. H. Hara of the Department of Botany, Faculty of Science, University of Tokyo and Prof. H. Iizuka of the Institute of Applied Microbiology, University of Tokyo for their kind guidance and constant

\* Department of Botany, Faculty of Science, University of Tokyo, Hongo, Bunkyo-ku, Tokyo. 東京大学理学部植物学教室

\*\* Institute of Fermentation, Yamanashi University, Kitashin-machi, Kofu, Yamanashi Pref. 山梨大学微生物研究所

encouragement, and finally the authors wish to express their appreciation to Dr. K. Tubaki of the Institute for Fermentation, Osaka, for his critical reading of the present manuscript.

### Enumeration

1. ***Aspergillus candidus*** Link (Moniliaceae) in Magaz. Ges. Naturf. Fr. Berlin **3**: 16 (1809) et Spec. Pl. **1**: 65 (1824); Fries, Syst. Mycol. **3**: 385 (1832); Sacc., Fung. ital. Tab. 704 (1881) et Syll. Fung. **4**: 66 (1886); Chaudhuri et Sachar in Ann. Mycol. **32**: 97 (1934); Tubaki in Nagaoa **4**: 4 (1954); Gilman, Soil Fungi Ed. 2. p. 231 (1957); Batista et Maia in An. Soc. Biol. Pernam. **15**: 188 (1957); Hirayama et Udagawa in Bull. Fac. Agr. Mie Univ. **16**: 19 (1958); Raper et Fennell, The Genus *Aspergillus* p. 347 (1965).

Syn. *Aspergillus* n. 4 Micheli, Nov. Plant. Gen. p. 213 (1729).

? *Monilia candida* Pers., Tent. Disp. Fung. p. 40 (1797) et Syn. Fung. p. 692 (1801).

*Sterigmatocystis candida* Sacc., Mich. **1**: 91 (1877) et Fung. ital. T. 80 (1881) et Syll. Fung. **4**: 72 (1886); Wehmer, Monograph p. 100 (1901).

*Sterigmatocystis candida* Bain. in Bull. soc. bot. Fr. **27**: 30 (1880), non Sacc. (1877); Sacc., Syll. Fung. **4**: 73 (1886), as *St. candidula*.

*Sterigmatocystis candida* (Sacc.) Schroeter, Schles. Krypt. Fl. Pilze **2**: 218 (1893); Wehmer, Monograph p. 98 (1901).

*Aspergillus candida* (Link?) Wehmer, Monograph p. 95, 141 (1901).

*Aspergillus candidus* (Link) Sacc. ex Wehmer, Monograph p. 98 (1901).

*Aspergillus candidus* (Pers.) Lindau, Rabenh. Krypt. Fl. **8**: 149 (1907), ? pro parte.

*Aspergillus niveocandidus* Lindau, Rabenh. Krypt. Fl. **8**: 151 (1907).

Colonies on potato-glucose agar, rather restrictedly growing, persistently white, or becoming creamy to yellowish creamy, reverse colorless. Conidiophores straight from submerged or aerial hyphae, up to  $1000\mu$  long by  $5-10\mu$  wide, smooth, colorless. Vesicles globose, but small vesicles often bearing only a limited number of primary sterigmata. Sterigmata occasionally uniseriate in small heads but almost in two series, colorless; primary sterigmata wedge-shaped,  $10\times 5-6\mu$ ; secondaries usually more uniform,  $7-9\times 3-4\mu$ . Conidia globose to subglobose,  $2-4\mu$  in diam.,  $3\mu$  in diam. in average. Cleistothecia and sclerotia not observed.

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Hura,

Karakorum, June 25, 1965.

Collection examined: an isolate from goat dung, Hispar Valley, near Hura, Karakorum, J. Sugiyama, Jan. 1966 (K2-2).

This fungus shows a world-wide distribution and is frequently found on dungs of various animals. Lindau (1907) and Tubaki (1954) have already reported the present species from goat dungs in Europe and America, and in Tokyo, Japan, respectively.

2. **Stemphylium ilicis** Tengwall (Fig. 1, Pl. I A, B & C) (Dematiaceae) in Meded. Phytopath. Labor. Willie Comm. Scholt. Baarn 6: 44 (1924); Neergaard,

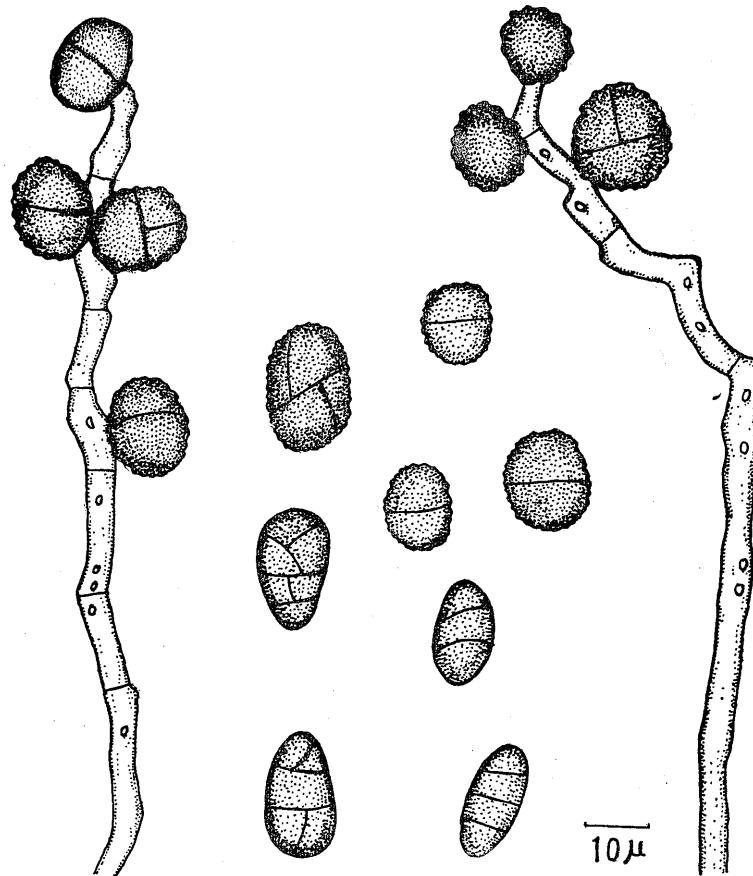


Fig. 1. *Stemphylium ilicis*, from K1-3, conidiophores and conidia.

*Alternaria* and *Stemphylium* p. 321 (1945).

Syn. *Alternaria abietis* Tengwall in Meded. Phytopath. Labor. Willie Comm. Scholt. Baarn 6: 50 (1924).

*Stemphylium congestum* Newton in Phytopath. 18: 576 (1928).

*Stemphylium dentriticum* De Souza da Camara, Acad. Sci. de Lisboa la class p. 12 (1930).

*Stemphylium congestum* Newton var. *minor* Ruehle in Mycologia 22: 308 (1930), syn. nov.

Hyphae subhyaline to Deep Olive-Buff, septate, about 3—5  $\mu$  wide. Conidiophores Deep Olive-Buff to Buffy Brown, septate, 50—150  $\mu$  long by 3—5  $\mu$  wide, unbranching or rarely branching, erect, geniculate with many scars at intervals of about 5—7  $\mu$ , developing singly as side branches on the hyphae or terminally; conidiophores not swollen terminally. Conidia formed acrogenically but through the continual growth of the conidiophores they get to occupy lateral positions on the conidiophores; conidia highly variable, almost spherical or regularly to irregularly ellipsoid, oval to pear-shaped to obclavate to cylindrical, smooth, echinulate or more or less verrucose, usually septate, one to four transverse septa or rarely none, one or more longitudinal septa or rarely none, Olive-Brown to Clove Brown, 5—18  $\times$  10—25  $\mu$ .

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Hura and Parolykish, Karakorum, June 25 and Aug. 28, 1965.

Collections examined: isolates from goat dung, Hispar Valley, near Hura and Parolykish, Karakorum, J. Sugiyama, Jan. 1966 (K1—2, K1—3, K1—4, K5—1, K5—2 and K5—3).

These isolates well agreed with the description provided by Neergaard (1945). This species was found for the first record on dung.

3. ***Sporobolomyces coprophilus*** Sugiyama et Goto, sp. nov. (Sporobolomycetaceae) (Fig. 2, Pl. I D)

In musto maltato cellulae ovoideae vel longi-ovoideae, 3—5  $\times$  6—13  $\mu$ , singulae, binae vel catenatae post dies 3 ad 25°C. Pelliculum rugosum formantur et e cellulis ballistosporis et hyphis compositum. Ballistosporae e sterigmatis sutem raro ejectae. In agarico maltato cultura nitida, umida, albida, exigue aspera et rufulocitrina post unum mensem ad 17°C. Pseudomycelii primitiva producta. Ballistosporae vel longi-ovoideae. Fermentatio nulla. Glucosum, sucrosum et maltosum

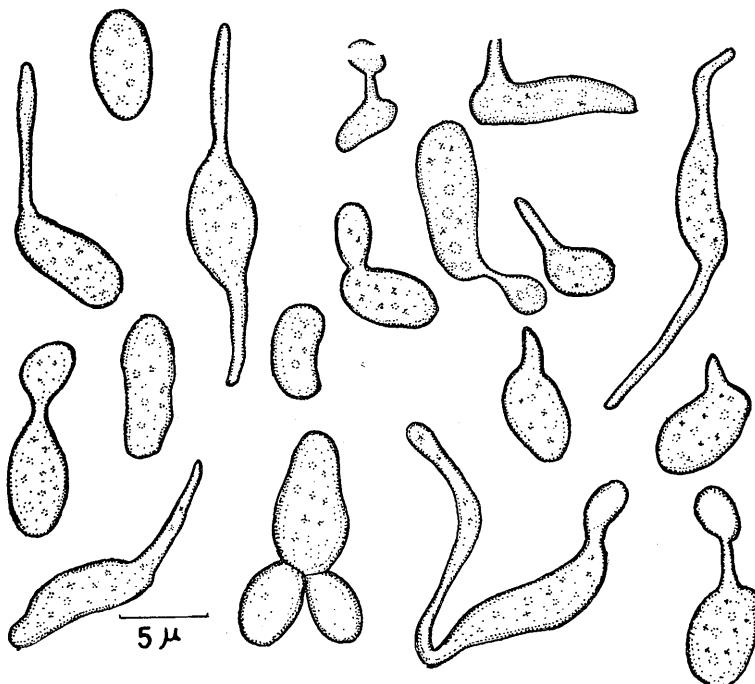


Fig. 2. *Sporobolomyces coprophilus*, from the type TI 0004, vegetative cells and sterigmata bearing ballistospores.

assimilantur, at non galactosum et lactosum. Nitras kalicus assimilatur. In medio minerali cum alcohole aethylico parum crescit. Arbutinum non finditur. Typus in TI conservatur.

Habitat in caprino fimo.

Typus in caprino fimo, Hispar Valley, prope Hura, Karakorum, 25. xi. 1965, leg. K. Ito, TI0004.

Growth in malt extract: after 3 days at 25°C, cells oval to long oval, 3—5.5 × 6—13  $\mu$ , single, in pairs and short chains. Pellicle formed wrinkled, consisting of budding cells, irregularly formed sterigmata, ballistospores and true hyphae. Sterigmata and ballistospores, however, are very rarely formed.

Growth on malt agar: after one month at 17°C, streak culture reddish orange, shiny, moist, smooth and slightly rough. Pseudomycelia, hypha-like sterigmata and ballistospores observed at the margin.

Slide cultures: primitive pseudomycelia formed.

Sporulation: ballistospores oval to long oval and rarely discharged.

Fermentation: absent. Sugar assimilation: glucose+, sucrose+, maltose+, galactose-, lactose-.

Assimilation of  $\text{KNO}_3$ : positive. Ethanol as sole source of carbon: scanty growth. Splitting of arbutin: negative.

Iodine reaction of the extracellular polysaccharide: negative.

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Hura, Karakorum, June 25, 1965.

Collection examined: on goat dung, Hispar Valley, near Hura, Karakorum, J. Sugiyama, Jan. 1966 (TI0004, Type). The type specimen deposited in TI\* and living cultures (K1-1) derived from the type will also be deposited at TI, IAM\* and IFYU\*.

The new species hereby described differs from *Sp. roseus* in having spores oval to long oval and in galactose not being assimilated.

4. **Cryptococcus neoformans** (Sanfelice) Vuillemin (Cryptococcaceae) in Rev. gén. sci. **12**: 732 (1901); Guilliermond, The Yeasts p. 354 (1920); Dodge, Medical Mycol. p. 330 (1935); Lodder, Die anaskosporogenen Hefen, sect. II, **32** (1): 154 (1934); Lodder et K.-van Rij, The Yeasts p. 377 (1952).

Syn. *Saccharomyces* sp. in Central. Bakt. **17**: 113 (1895).

*Saccharomyces neoformans* Sanf. in Ann. Ig. Sperim. **5**: 239-262 (1895);

Stelling-Dekker, Die sporogenen Hefen **28** (1): 123 (1931).

*Torula neoformans* (Sanf.) Weis in Jour. Med. Res. **7**: 208-311 (1902).

*Blastomyces neoformans* (Sanf.) Arzt. in Arch. Derm. Syphilis **145**: 311 (1925).

*Torulopsis neoformans* Almeida in Ann. Fac. Med. São Paulo **9**: 10 (1933).

Growth in malt extract: after 3 days at 25°C, cells globose, 4.5-12  $\mu$ , single, in pairs and short chains.

Growth on malt agar: after one month at 17°C, streak culture creamy, shiny, moist, smooth, and slimy to fluid.

Slide cultures: no pseudomycelium. Sporulation: absent. Fermentation:

\* Names of the herbaria are listed by using the following abbreviations: TI refers to the Herbarium of the Department of Botany, University of Tokyo, IAM to the Herbarium of the Institute of Applied Microbiology, University of Tokyo, and IFYU to the Institute of Fermentation, Yamanashi University.

absent.

Sugar assimilation: glucose+, galactose+ (very weak), sucrose+, maltose+, lactose- (sometimes very weak).

Assimilation of  $\text{KNO}_3$ : negative. Ethanol as sole source of carbon: no growth.

Splitting of arbutin: slightly positive.

Iodine reaction of the extracellular polysaccharide: positive. Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Parolykish, Karakorum, Aug. 28, 1965.

Collection examined: an isolate from goat dung, Hispar Valley, near Parolykish, Korakorum, J. Sugiyama, Jan. 1966 (K6-10).

5. **Cryptococcus albidus** (Saito) Skinner (Cryptococcaceae) in Herici's Molds, Yeasts and Actinomycetes 2nd ed., New York, p. 288 (1947); Lodder et K.-van Rij, The Yeasts p. 387 (1952); Lund, Studies on the ecology of yeasts p. 104 (1954); Soneda, Biol. Results J. A. R. E. no. 15 p. 3 (1961).

Syn. *Torula albida* Saito in Japan. J. Bot. 1: 1 (1922).

*Torulopsis albida* (Saito) Lodder in Die anaskospogenen Hefen, sect II, 32 (1): 163 (1934).

Growth in malt extract: after 3 days at 25°C, cells globose, 5-9  $\mu$ , single, in pairs and short chains. Ring formed.

Growth on malt agar: after one month at 17°C, streak culture creamy, shiny, moist, smooth and slimy.

Slide cultures: no pseudomycelium. Sporulation: absent. Fermentation: absent.

Sugar assimilation: glucose+, galactose+ (very weak), sucrose+, maltose+, lactose+ (very weak).

Assimilation of  $\text{KNO}_3$ : positive. Ethanol as sole source of carbon: scanty growth. Splitting of arbutin: negative.

Iodine reaction of the extracellular polysaccharide: positive.

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Hura and Parolykish, Karakorum, June 25 and Aug. 28, 1965.

Collections examined: isolates from goat dung, Hispar Valley, near Hura and Parolykish, Karakorum, J. Sugiyama, Jan. 1966 (K1-6 and K6-8).

This species shows a world-wide distribution. Lund (1954) reported the occurrence of the present species in dungs of various animals in Denmark, and likewise Soneda (1959) discovered this species in dungs collected in the Ueno Zoologi-

cal Garden, Tokyo and at the foot of Mt. Fuji, Yamanashi Pref., Japan, respectively.

6. *Cryptococcus albidus* (Saito) Skinner var. *ovalis* Sugiyama et Goto, var. nov. (Cryptococcaceae) (Fig. 3, Pl. I E)

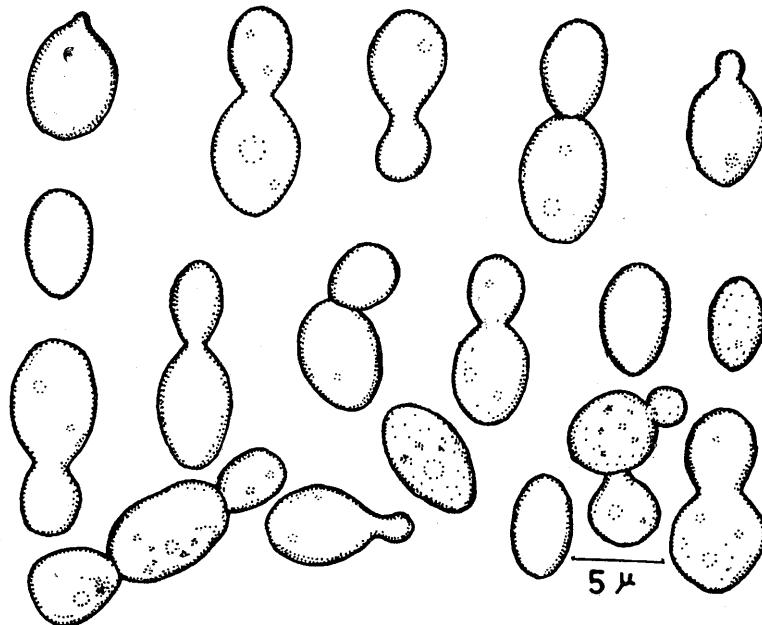


Fig. 3. *Cryptococcus albidus* var. *ovalis*, from the type TI 0005, vegetative cells.

Haec varietas a specie differt: In musto maltato cellulae subglobosae vel ovales, singulæ vel binae,  $3.5-10 \times 5-10 \mu$ . In medio minerali cum galactoso non crescit (valde exigue). Affectio ex iodo griseo-lazulina vel viridi-fusca in colore. Typus in TI conservatur.

Habitat in caprino fimo.

Typus in caprino fimo, Hispar Valley, prope Parolykish, Karakorum, 25. xi. 1965, leg. K. Ito, TI0005.

Growth in malt extract: after 3 days at  $25^{\circ}\text{C}$ , cells globose to oval,  $3.5-10 \times 5-10 \mu$ , single or in pairs. Thin pellicle formed.

Growth on malt agar: after one month at  $17^{\circ}\text{C}$ , streak culture pale light brownish gray, shiny, slightly rough and very moist.

Slide cultures: no pseudomycelium. Sporulation: absent.

Sugar assimilation: glucose+, sucrose+, maltose+, lactose+ (weak), galactose— (sometimes very weak).

Assimilation of  $\text{KNO}_3$ : positive. Ethanol as sole source of carbon: scanty growth. Splitting of arbutin: negative.

Iodine reaction of the extracellular polysaccharide: positive, moreover color is grayish blue to greenish brown.

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Parolykish, Karakorum, June 25, 1965.

Collection examined: on goat dung, Hispar Valley, near Parolykish, Karakorum, J. Sugiyama, Jan. 1966 (TI0005, Type).

The type specimen deposited in TI and living cultures (K6—7) derived from the type will also be deposited at TI, IAM and IFYU.

The variety hereby described as var. *ovalis* differs from var. *albidus* in having pellicles and vegetative cells subglobose to oval. Galactose assimilated in var. *ovalis* but not in var. *albidus*, and also the iodine reaction of var. *ovalis* very characteristic, showing grayish blue to greenish brown in color.

7. **Rhodotorula marina** Phaff, Mrak et Williams (Cryptococcaceae) in Mycologia **44**: 436 (1952); Hasegawa, Banno et Yamauchi in Journ. Gen. Appl. Microbiol. **6**: 210 (1960); Ito, Mycol. Fl. Japan **3** (1): 183 (1964).

Syn. *Rhodotorula tokyoensis* Kobayashi in Rep. Wood. Saccharific. Disc. Comm. **2**: 93 (1953), nom. nud.

Growth in malt extract agar: after 3 days at  $25^\circ\text{C}$ , cells oval,  $2.5-4 \times 4-6\mu$ , single or in pairs.

Growth on malt agar: after one month at  $17^\circ\text{C}$ , streak culture pale whitish orange, shiny, smooth, moist and slimy.

Slide cultures: no pseudomycelium. Sporulation: absent. Fermentation: absent.

Sugar assimilation: glucose+, galactose+ (weak), sucrose+, maltose+ (weak), lactose+ (weak).

Assimilation of  $\text{KNO}_3$ : negative. Ethanol as sole source of carbon: no growth. Splitting of arbutin: negative.

Iodine reaction of the extracellular polysaccharide: negative.

Habitat: on goat dung, collected by K. Ito in Hispar Valley, near Parolykish, Karakorum, Aug. 28, 1965.

Collection examined: an isolate from goat dung, Hispar Valley, near Parolykish, Karakorum, J. Sugiyama, Jan. 1966 (K6—9).

This fungus will be added for the first record to the dung mycoflora.

### Summary

1. Seven species of coprophilous fungi, including one new species, i.e., *Sporobolomyces coprophilus* and one new variety, i.e., *Cryptococcus albidus* var. *ovalis*, were reported from goat dungs collected in Hispar Valley, Karakorum, Pakistan.
2. *Aspergillus candidus* and *Cryptococcus albidus* show a world-wide distribution on animal dungs.
3. These fungi, i.e., *Stemphylium ilicis*, *Sporobolomyces coprophilus*, *Cryptococcus neoformans*, *Crypt. albidus* var. *ovalis* and *Rhodotorula marina*, will be added for the first record to the dung mycoflora.

### References

- Ginai, M. A. 1936. Further contribution to our knowledge of Indian Coprophilous Fungi. J. Indian Bot. Soc. **15**: 269—284. Lindau, L. 1907. Rabenhorst's Kryptogamen-Flora **8**: 149. Lund, A. 1945. Studies on the ecology of yeasts. Munksgaard, Copenhagen, 132 pp. Mahju, N. A. 1933. A contribution to our knowledge of Indian coprophilous fungi. J. Indian Bot. Soc. **12**: 153—164. Neergaard, P. 1945. Danish species of *Alternaria* and *Stemphylium*. Einar Munksgaard, Pub., 560 pp. Soneda, M. 1959. Studies on animal-dung inhabiting yeast. Nagaoa **6**: 1—34. Tubaki, K. 1954. Studies on the Japanese Hyphomycetes (1) Coprophilous group. Nagaoa **4**: 1—20.

### Explanation of the plate I

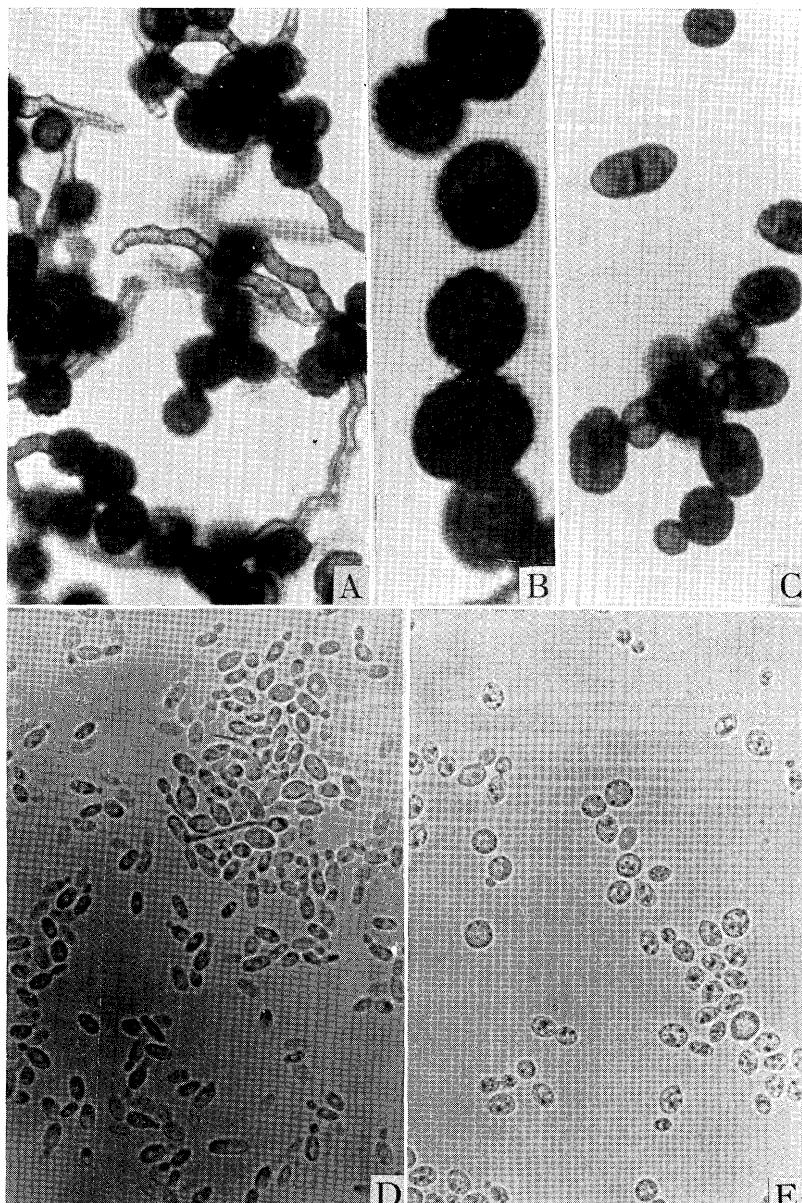
A—C. *Stemphylium ilicis*, from K1—3, conidiophores and conidia (A, C—× ca. 670; B—× ca. 1330).

D. *Sporobolomyces coprophilus*, from the type TI 0004, vegetative cells and sterigmata bearing ballistospores (×ca. 670).

E. *Cryptococcus albidus* var. *ovalis*, from the type TI 0005, vegetative cells (×ca. 670).

\* \* \* \*

東京大学カラコルム遠征隊(1965年)の一員として現地に派遣された伊藤邦幸氏(京都大学)によって、カラコルム地方のヒスパー谷に棲息する山羊の糞が多数採集され、著者らはこれらの試料から約20株の糞生菌を分離し、ここにその一部を報告した。本報では、*Aspergillus candidus*, *Stemphylium ilicis*, *Sporobolomyces coprophilus*(新種), *Cryptococcus neoformans*, *Crypt. albidus*, *Crypt. albidus* var. *ovalis*(新変種), *Rhodotorula marina*の7種類を扱った。これらのうち*Aspergillus candidus*と*Cryptococcus albidus*はたびたび糞生菌として世界各地から報告されている。



J. SUGIYAMA & S. Goto: Coprophilous fungi from Karakorum